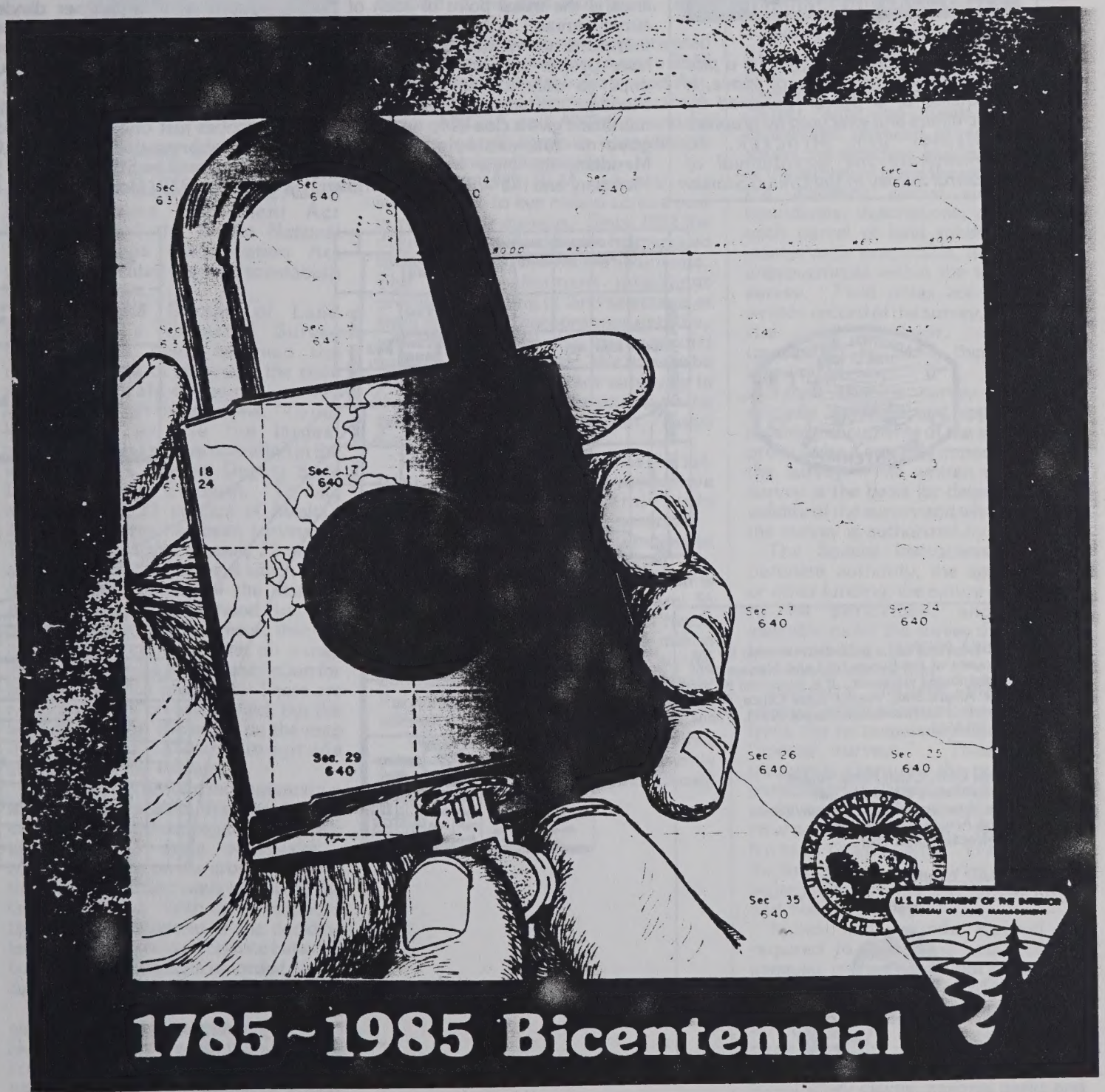
BLM-AK-AE-85-009-1120-912

Special Issue

ALASKA PEOPLE

1985 Volume VII Number VI

Cadastral Survey - Unlocking the Legacy of the Land



1785~1985 Bicentennial

THE COVER

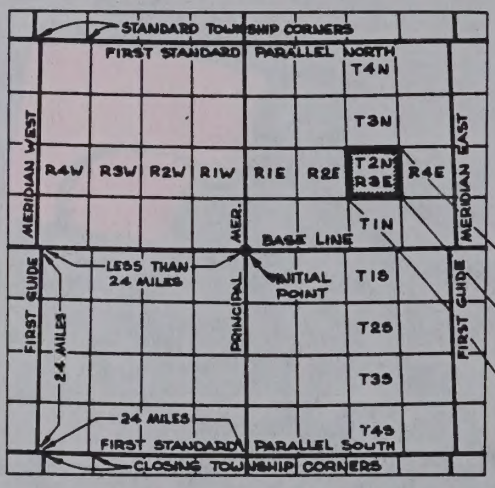
Earth, symbolically depicted by a plat floating in the maelstrom of space, is the theme of a poster designed by public affairs and executed by graphics illustrator Jim Mroczek, to commemorate the bicentennial of Cadastral Survey in the United States.

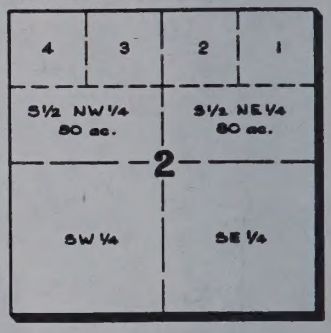
The Rectangular Survey System

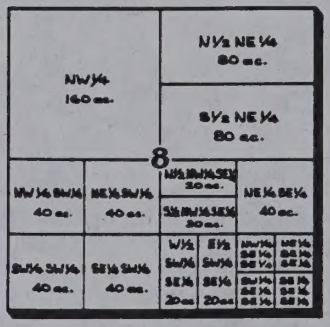
Surveying every area of the United States from Florida to Alaska is a large undertaking. Obviously such a job cannot be completed all at once. Thirty-seven key reference points enable many small surveys to be done at the same time and also provide for correcting distortions which occur when the round earth is drawn on a flat map. There are 31 principal meridians and base lines in the contiguous United States and five in Alaska. At the intersection of these two lines is the initial point of each of the survey areas. A few of the principal meridians are numbered and the rest have proper names. The numbered ones go only to the Sixth Principal Meridian. Most of the other (named) meridians give a clue as to the area they govern: for example, the Boise Meridian, the New Mexico Principal Meridian, and the Willamette Meridian.

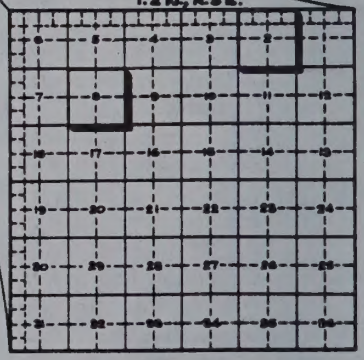
Townships are numbered north or south of the base line. A line or column of townships is called a range, and they are numbered east or west of the principal meridian.

Each six-mile-square township is divided into one-mile square sections numbered from one to 36. The section numbers run in opposite directions in alternate lines, beginning with section number one in the northeast corner of the township. These numbered sections may be further divided into allquot parts and thus described and identified. The southeast quarter of the southeast quarter of Section 5, Township 2 North, Range West of the Boise Meridian describes just one parcel of land. The BLM abbreviations of this 10 acre parcel would be SE ¼, SE ¼, SE ¼, Sec. 5, T 2N., R3W Boise Meridian, Idaho.







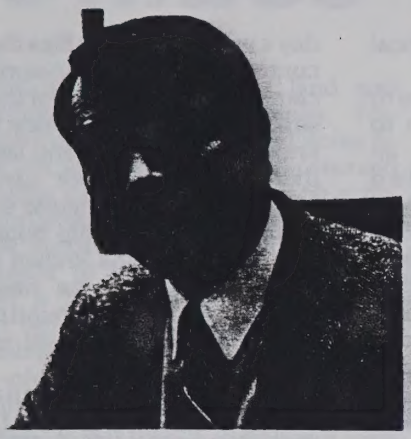


ALASKA PEOPLE is published monthly for the employees of the Bureau of Land Management and distributed statewide. It is produced by the Public Affairs Staff, Alaska State Office, 701 C Street, Box 13, Anchorage, Alaska 99513. Phone (907) 271-5555.

George Gurr, Chief, Public Affairs
Paul Savercool, Editor-in-Chief
Tricia Hogervorst-Rukke, Writer/Editor
Valerie Arruda, Typesetting
Jim Mroczek, Illustrator

Ed Bouy, Contributing Writer

Surveying Alaska: A World Class Job



Francis Eickbush

Surveying Alaska is no small feat. The passage of the Native Allotment Act, Alaska Statehood Act, the Alaska Native Claims Settlement Act (ANCSA), and the Alaska National Interest Lands Conservation Act (ANILCA) created the need to establish land boundaries.

The Alaska Bureau of Land Management's Cadastral Survey Division has been assigned the monstrous task of surveying the state and uses state-of-the-art survey equipment to get the job done. "To our knowledge we are the largest rectangular land survey operation in the world," says Cadastral Deputy State Director Frances Eickbush. "To date approximately 21 percent of Alaska's 375 million acres has been surveyed. This includes approximately 32 million acres of protracted surveys which were done at the request of the state of Alaska under the Statehood Act. By protracted surveys we mean that we have laid a rectangular grid on a map base to determine a legal description for land conveyance purposes. There are no monuments on the ground, but the legal description shows up on the map in terms of latitude/longitude coordinates," he explained.

Although the ground monumentation is far more desirable, this was done to expedite the land conveyance of certain areas to the state of Alaska. Monumentation on the ground is one of the most important ways to identify the lands conveyed. With rare exceptions the survey monument is the deciding factor when there is a variance between bearings and distances recorded on the survey plats.

Some of Alaska's terrain, such as glaciers and steep mountain ranges, will likely not be surveyed for many years to come. Other areas designated as national monuments, parks, or wildlife refuges will have only their boundaries surveyed.

"We use a lot of high technology satellite mapping which is very accurate when related to latitude and longitude points on the earth. This is used for the management of large areas. The use of high tech and changes in field operations have helped speed up our progress tremendously. Our production capabilities have nearly doubled in the past four years," says Eickbush.

Most of today's surveys are oriented toward selection priorties given to BLM by the state under the Statehood Act, by the village and regional corporations under ANCSA and ANILCA, and by various federal agencies according to their administrative needs.

Prior to 1982 BLM cadastral was surveying up to five million acres a year in rectangular surveys. Since 1982 the thrust of the program has moved toward finishing the Native allotments. The Native allotment inholdings preclude patenting of land selections of state and Native corporations until they are identified and the on-the-ground surveys are performed. "We hope to be done with the small tract surveying in the next 10 to 15 years depending on the funding for the program," says Eickbush.

The cadastral program has 98 full-time employees, 30 cooperative education students, and hires approximately 30 summer seasonals. At full capacity about 160 employees are on the payroll.

The current survey appropriation is about $13 million, of which nearly $6 million goes to various contract needs including three and one-third million which are direct dollars to survey contractors. Any additional funding to the program goes to contracting out additional areas for survey.

"We project that it will take 40 more years to complete all the presently identified survey needs," says Eickbush.

What is a Cadastral Survey?

Cadastral surveys deal with one of the oldest and most fundamental facets of human society — ownership of land. Surveys create, mark, define, retrace, or reestablish the boundaries and subdivisions of the public lands of the United States.

The official record of the field work of a cadastral survey ordinarily consists of a plat and field notes, both of which must be approved by the proper authority. A plat, as used technically by BLM, is a drawing that represents the area included in a survey (such as a township, private land claim, or mineral claim) and the lines surveyed, established, retraced, or resurveyed. It shows the direction and length of each of the surveyed lines; the relationship to the adjoining official surveys; the boundaries, descriptions, and area of each parcel of land subdivided; and, insofar as is practicable, the relief and improvements within the limits of the survey. Field notes are the official written record of the survey, certified by the field surveyor. Originally transcribed by hand, they are now typewritten.

Years after a survey has been officially accepted and approved, the initiating documents of the survey often prove to be a critically important part of the survey. The written request for survey is the basis for determining the validity of the survey and whether or not the survey is authorized by law.

The Special Instructions cite the pertinent authority, the appropriation or other funding, the nature of the work to be performed, and specific instructions for the survey that may not be covered in the current "Manual of Surveying Instruction."

Cadastral surveys that involve unusual applications of, or departures from, the rectangular system are called "special surveys." These surveys frequently carry out the provisions of particular legislative acts and include such work as small tract surveys, townsite surveys, homesite, homestead, and trade and manufacturing site surveys; mineral segregation surveys and various metes and bounds surveys.

Metes and bounds surveys are required to define the boundaries of irregular tracts that do not conform to legal subdivisions. Ordinarily this involves the establishment of the boundaries of claims, grants, or reservations such as Indian reservations, small-holding claims, forest entry claims, national parks and national monuments.

Modern Technology Revo

For hundreds of years going out to survey an area meant setting up a transit, cutting a straight line through thick forests, swamps, jungles, or whatever else was encountered, and working from one survey point to the next.

Today, advances in modern technology have revolutionized survey methods. The use of helicopters has helped increase surveying production substantially. Until 1970 BLM Cadastral used a fledgling system of electronic control surveys performed by helicopters hovering over specific points. This system allowed BLM to survey about 1/2 million acres per year and was considered an adequate production rate until the passage of the Alaska Native Claims Settlement Act (ANCSA) in 1971. ANCSA drastically increased the lands which needed to be surveyed, putting pressure on the cadastral survey program. It seemed everyone involved wanted their land surveyed yesterday.

The three autosurveyor inertial guidance systems have increased Cadastral Survey's capabilities from 1/2 million acres surveyed in 1970 to 1 1/2 million acres in 1984.

In an effort to increase production, BLM began exploring the applicability of military inertial guidance systems to surveying problems. At that time the military was using inertial guidance systems mounted in jeeps to determine the latitude and longitude of critical enemy positions.

BLM worked with Litton Industries to adapt the inertial guidance system to surveying. By 1973 Litton had an accepted prototype (called autosurveyor) which BLM began field testing. The autosurveyor increased survey capabilities and expedited field surveys so much that in 1976 BLM purchased two more systems. The three autosurveyor inertial guidance systems have increased Cadastral Survey's capabilities from 1/2 million acres surveyed in 1970 to 1 1/2 million acres in 1984. With the use of the autosurveyor, the modern surveyor can establish an average of 25 positions for monumentation in a single day. Using the old chainsaw and clearing line-of-sight method, a surveyor averaged 2-3 corner positions per day.

What does the autosurveyor inertial guidance system do? It allows a surveyor to accurately determine any position on the earth's surface.

First thing in the morning the surveyor powers up the system and aligns the autosurveyor with the established survey point on which it is presently located. In other words, the surveyor tells the autosurveyor where on the earth's surface it is located by feeding it the latitude and longitude and the elevation of its present location.

The system must then be left undisturbed for one hour while it aligns itself to true north and south.

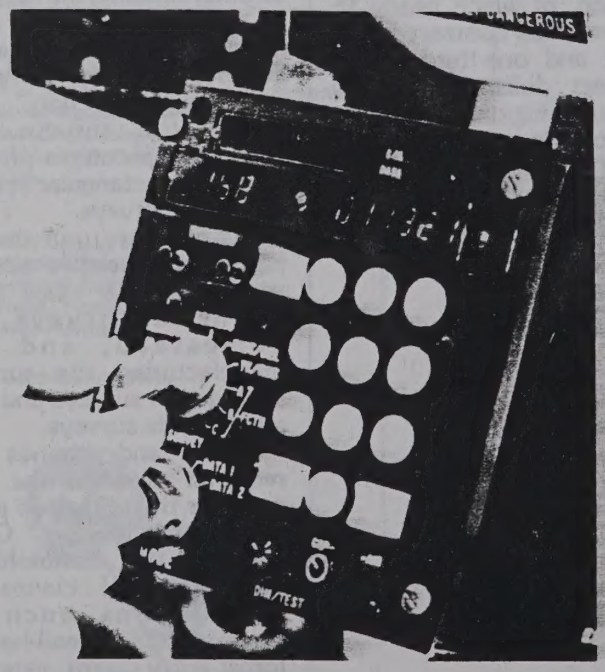
After an hour it is ready to begin the day's work. The pilot flies the helicopter containing the autosurveyor from base camp to the beginning of the area to be surveyed. The pilot finds the nearest known survey point and lands on it so that the autosurveyor can update its location. For rectangular surveys such as putting in township boundaries, the pilot flies from one known point to the next establishing the needed points inbetween. Survey ground crews follow and establish permanent monumentation.

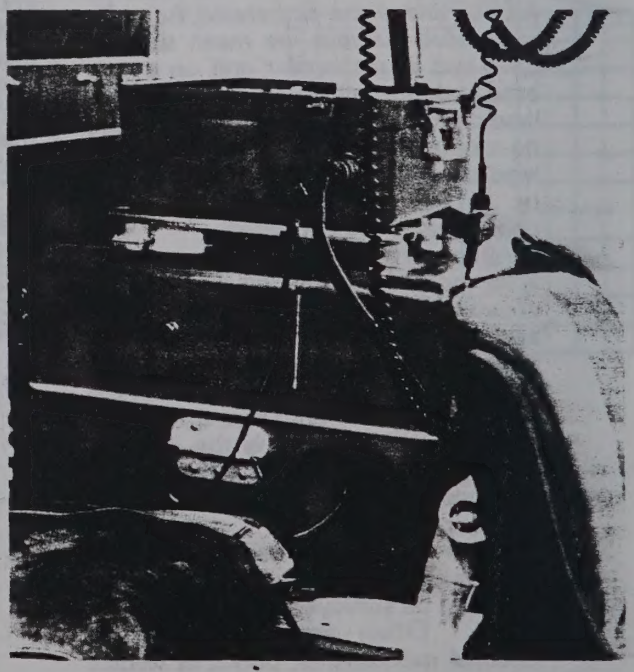
For obtaining menader line information the helicopter containing the autosurveyor flies along the banks of rivers, streams and lakes. Each time there is a change in the contour of the waterbody the pilot hits a switch which marks the point within the autosurveyor.

The autosurveyor operator flies the perimeter of lakes 50 acres or more within a township to determine the exact number of acres of land in that township.

At the end of the day the data is fed into a computer at camp. The computer prints out an outline of what was surveyed and draws in latitude and longitude points established during the day. This information can be transferred to a map to help update meander line information for the area showing changes in the rivers, streams, etc. from the original surveys.

With the myriad lakes and marshes in





ɹtionizes BLM Surveying

Alaska, sorting out what's land and what's water can be a challenge. The general rule has been lakes 50 acres or more are segregated out and reserved for public use; lakes less than 50 acres are surveyed as land and conveyed.

The autosurveyor operator flies the perimeter of lakes 50 acres or more within a township to determine the exact number of acres of land in that township. Without the autosurveyor, the information would have to be obtained by doing on-the-ground surveys, which means dragging a steel tape along the mean high water mark of the lake or by obtaining a rough figure from rectified orthophotos.

Today inertial guidance systems such as the the autosurveyor are quite common. They are used to help navigate 747 jets and are used on all overseas jet flights. The space shuttle program also depends heavily on inertial guidance systems.

Although the autosurveyor is very useful for meander line and rectangular survey work, it must have previously established control points at about 12 to 1 mile intervals. To establish these control points, cadastral utilizes satellite Doppler technology. The Doppler System was adapted for surveying use with the Transit satellite system developed by the U.S. Navy in the early 1960's. The Transit satellite system was used by the Navy's Polaris submarine fleet to find their way at sea to keep ballistic missles on target. In a state as vast as Alaska, known survey points are often few and far between. Only a skeletal framework of survey control points exists across Alaska. The Geodetic Support Group from the Branch of Cadastral Field Surveys goes into an area in advance of major survey projects and indentifies this basic framework of survey points.

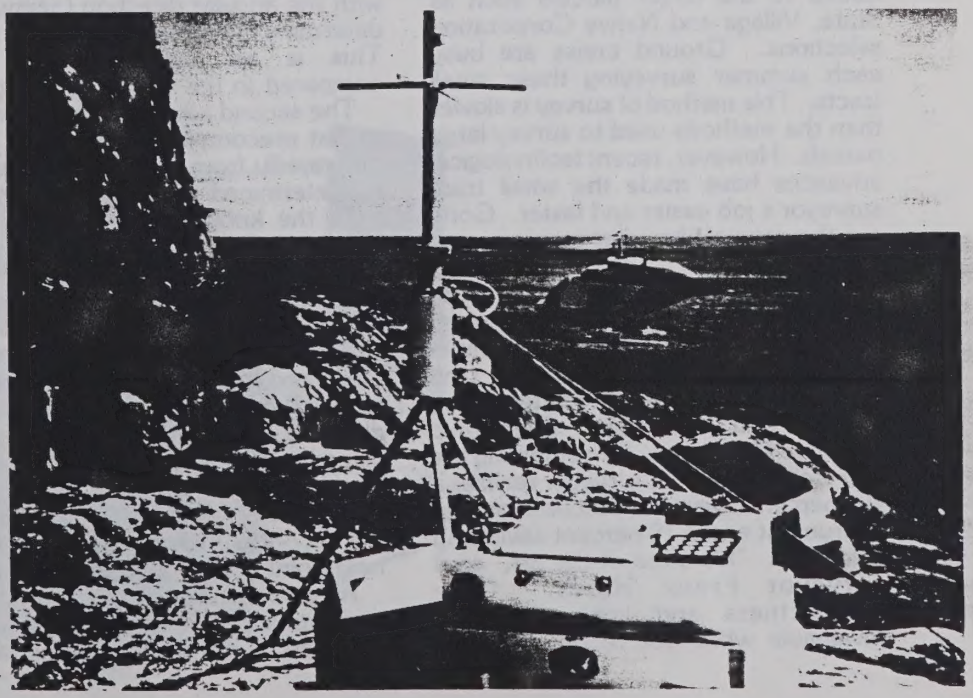
The Doppler System establishes latitude and longitude points any where on the earth's surface 24 hours a day in any weather by taking readings off five Transit satellites.

The Doppler system establishes latitude and longitude points any where on the earth's surface 24 hours a day in any weather by taking readings off five Transit satellites. The Transit satellites continually travel around the earth in polar orbits 600 miles above the earth's surface. One of the five Transit satellites passes within range every 1 1/2-2 hours. As they travel around the earth, they continuously broadcast a serial stream of digital data. Just as a train whistle gets louder as it comes toward you and the sound dies as the train moves away, so the Doppler receives the satellite's frequency and is able to distinguish exactly when the satellite is directly overhead and when it has passed by. Doppler uses this satellite information to establish the exact latitude and longitude of the location of the receiver antenna. In Alaska, BLM presently uses five Doppler systems.

Although Doppler positioning has dramatically improved Cadastral's capability to determine latitude and longitude, the receiver must sit in one location for 1 to 2 days until enough satellite data is collected to accurately compute the latitude and longitude of its location.

Cadastral is continually looking for new ways to improve their capabilities. In the next few years BLM hopes to utilize a new system developed by the military called the Global Positioning System (GPS). This new system can provide latitude and longitude positioning within 10 minutes after it has been set up. GPS's almost instantaneous information will be a considerable time and money saver. At the present time there are not enough satellites in orbit to make GPS practial, but as the military launches new satellites, BLM hopes to start using GPS within the next few years.

Although some survey work must still be done on the ground, adaptation of space age technology has helped thrust surveying into the 21st century. BLM Alaska's Cadastral program is the largest of its kind in the world. With millions of acres still left to survey, each new addition of modern technolgy helps to move us closer to finishing the massive job which has been delegated.

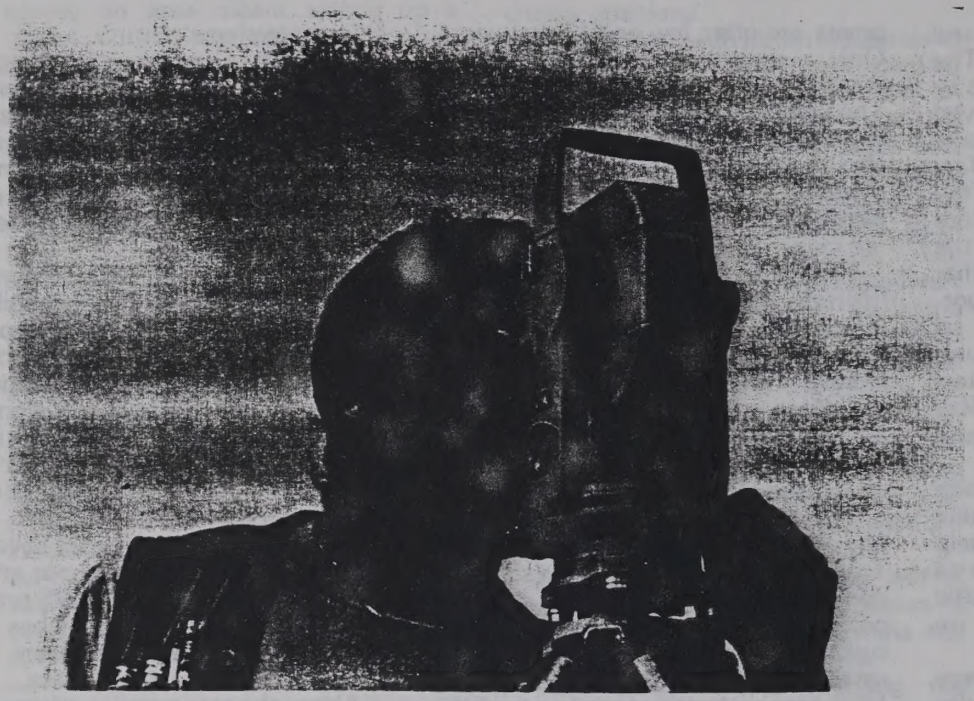


(far left) The autosurveyor controls

(middle) The autosurveyor--a simple looking box--an invaluable tool to the modern surveyor

(right) The Doppler System

The Total Station and Gyrotheodolite: Modern Tools of the Small Tract Surveyor



Surveyor Frank Hardt operates the Total Station

Scattered throughout Alaska are small parcels of land such as Native Allotments, trade and manufacturing sites, homesites and headquarters sites which need to be surveyed prior to patent. Often the conveyance of large tracts of land is delayed because the survey-patent process has not been completed on these small tracts. As a result, the current thrust of Cadastral activity in BLM Alaska is to delineate these small tracts so patent can be issued to the larger parcels such as State, Village and Native Corporation selections. Ground crews are busy each summer surveying these small tracts. This method of survey is slower than the methods used to survey large parcels. However, recent technological advances have made the small tract surveyor's job easier and faster. Gone are the days of the solar compass and steel chain.

The modern on-the-ground surveyor employs many instruments - the most popular being the Total Station. This is a combination of the theodolite (the modern day instrument for determining angles) and the EDM (Electronic Distance Measurer). By combining the two technologies the surveyor realizes a 40 percent weight reduction in the instrument and a 10 percent savings in field time. "It's state of the art," says surveyor Frank Hardt. "The compactness and light weight is invaluable when you've got to travel through swamps, over tundra or through high brush and timber." This unit enables the surveyor to measure angles and distances simultaneously. The distance is measured by bouncing an infrared light beam off of a reflector at the point to be determined. The speed of this light beam and the atmospheric effects on the speed are known. By measuing the time delay in the returning beam, the distance is determined. The distance is combined with the angular direction (azimuth) to determine the position of the new point. This is an immense time saver compared to the transit-tape method.

The second advantage of this system is that precomputed points can be set out rapidly from one known position. Predetermined angles and distances from the known point to the desired points can be quickly measured simply by turning the desired angle and positioning a second surveyor on the resulting line. This second surveyor then holds the reflector, the distance is measured, and the mirror moved forward or backward to the desired distance. A physical marker is then placed on the ground and verified with a new angle and distance. This point having been established and verified, the second surveyor moves on to the next point and the process is repeated.

All surveys consist of distances and directions. Distances are easily obtained by using a measuring tape or EDM. Relative angular direction is similarly easy to determine. However, for most survey purposes, the directions must be related to true north. Since the dawn of surveying, surveyors have relied on astronomic observations of the sun, moon and stars to determine azimuth (the direction measured clockwise from north). Observations of the sun are still prevalent today, but when Alaska's skies are cloud-filled it's all but impossible. A recent development called the gyrotheodolite is often used to determine azimuth. A gyroscopic unit is mounted on top of a standard theodolite and is aligned with the line of sight of the theodolite. The theodolite is then sighted on the line of which the surveyor wishes to find the azimuth. The gyroscope senses the spin of the earth and relates its relative direction to north. The resulting difference is displayed as a digital readout of the azimuth. The process takes nine minutes and is quite accurate.

BLM Alaska has a staggering surveying work load. Modern technologies have made the surveyors' technical work easier but it takes dedicated professionals to perform the work. BLM Cadastral is staffed by many such individuals. Through the efforts of these individuals, BLM is honoring its commitments toward surveying the vast Alaska territory.

Orthophotos - An Integral Tool of the Survey Trade

by Lynette Nakazawa

When the Alaska Statehood Act (1958) and the Alaska Native Claims Settlement Act (1971)(ANCSA) granted land to the state of Alaska and private Native corporations, the Division of Cadastral Survey was delegated the responsibility of surveying all federal lands designated for conveyance. Recognizing the vast number of water bodies in Alaska and the problems and cost that would be associated with conducting surveys in the conventional manner, ANCSA required only a skeletonized survey pattern with two-mile monumentations. On-the-ground survey of meander lines (shorelines) was not required.

While this system reduced the number of miles of on-the-ground survey required, problems arose in producing a survey plat with sufficient detail from which patent could be issued. The main problem was determining meander lines without an on-the-ground survey. This is now done using aerial photographs.

The Branch of Photogrammetry produces a photograph for each township requiring meander lines.

The Branch of Photogrammetry produces a photograph for each township requiring meander lines. To use an aerial photograph which can be used as a map, photogrammetrists and photolithographers use highly technical, computer-aided equipment to remove photo distortions caused by camera tilt and ground relief. This corrected photo is printed at a two inch to a mile scale and used as a base map for each township needing meander lines.

Data from the ground survey is computerized to draw out a township map showing the location of survey points and tracts. This map is at the same scale as the photo, and is used to aid in the placement of the township and section lines onto the corrected photo base. The photo helps identify calculations or entry errors in ground survey data.

The land surveyor and biologist determine where the meander lines will be placed when they conduct the on-the-ground review of the area where meander lines will be mapped.

Meander lines are determined by biologists trained in photo interpretation (examining photographic images to identify objects and judge their significance). The land surveyor and biologist determine where the meander lines will be placed when they conduct the on-the-ground review of the area where meander lines will be mapped. The surveyor works under the guidelines of the Cadastral Survey Manual of Survey Instructions and the biologist applies principles of photointerpretation and ecology to the surveyer's shoreline determination.

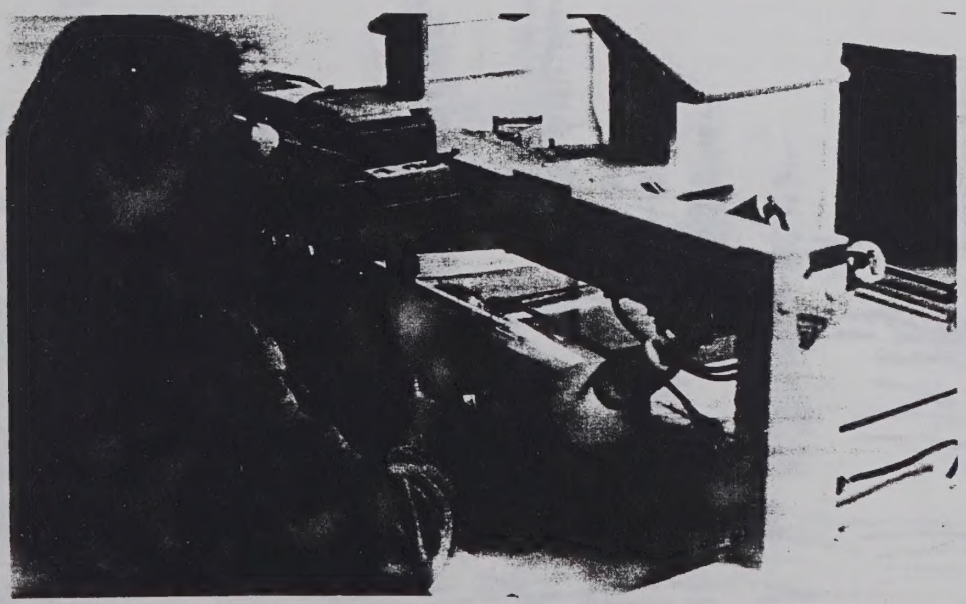
In the office, the biologist manually draws the meander line onto the corrected base photo. The land surveyor then inspects each photo interpreted township to ensure that the photointerpretation and the placement of computerized survey data meet survey requirements.

Each township must be computer-processed to determine land area to be conveyed. Input of the photo interpreted meander lines is achieved through a digitizing process which converts each ink line into a string of points or digital line.

The computer is able to use the data in this digital format to calculate land acreage and to produce a township map showing the land parcels. The computer products, which are township maps showing land parcels, are given to the Cadastral Survey drafting unit to complete additional rectangular survey plat drafting requirements.

These final products receive a final critical review to ensure accuracy of all pieces, field survey data position, photo interpreted/digitized meander lines, and final drafting, prior to approval of the plat.

The Division of Cadastral Survey Branch of Cartography and Examination and the Division of Operations Branch of Photogrammetry work closely in an effort to insure that the most correct and accurate data base is used to produce the BLM survey plats.



Dayle Sherba, general biologist photointerpretes a corrected orthophoto for meanderline mapping.

Cadastral Communications

Situation 1: Your survey crew needs more gasoline, food and supplies.

Situation 3: A man on a survey crew has had a serious accident and needs to get to a hospital.

Problem: The nearest telephone is one thousand miles away. What do you do?

Solution: Send a message to Anchorage by way of a meteor!

This solution is not science fiction but science fact. The above situations are examples of uses of a relatively new communications technology that BLM Alaska is using to help manage public lands. And in a state with the dimensions of Alaska, communication is complicated by a variety of unusual factors.

Alaska is a land of contrasts. Covering 565,000 square miles, it is the largest state (more than twice the size of Texas!) in the Union, but it is also the smallest state if measured by population. Population density is .74 people per square mile, but even this figure is misleading because most of the population lives in a few large cities. The Anchorage area alone accounts for about 42 percent of the state's population. There are few roads; most access to the vast expanses of federal land must be by airplane. The long Alaskan winters and limited daylight conditions are famous. Summer field seasons generally average from late May to late September. All this is to say that resource data collection for any purpose is difficult, expensive, and time consuming.

These factors led a number of agencies in data collection and resource management to pool their expertise and funding to develop a communications system suitable for environmental data monitoring and point-to-point communications in Alaska.

A commercial meteor burst system, pioneered by Western Union, was chosen as the system which had the best possibility to meet Alaska's needs. Design specifications were developed by a joint study committee, actual manufacture of the prototype units was done by private companies.

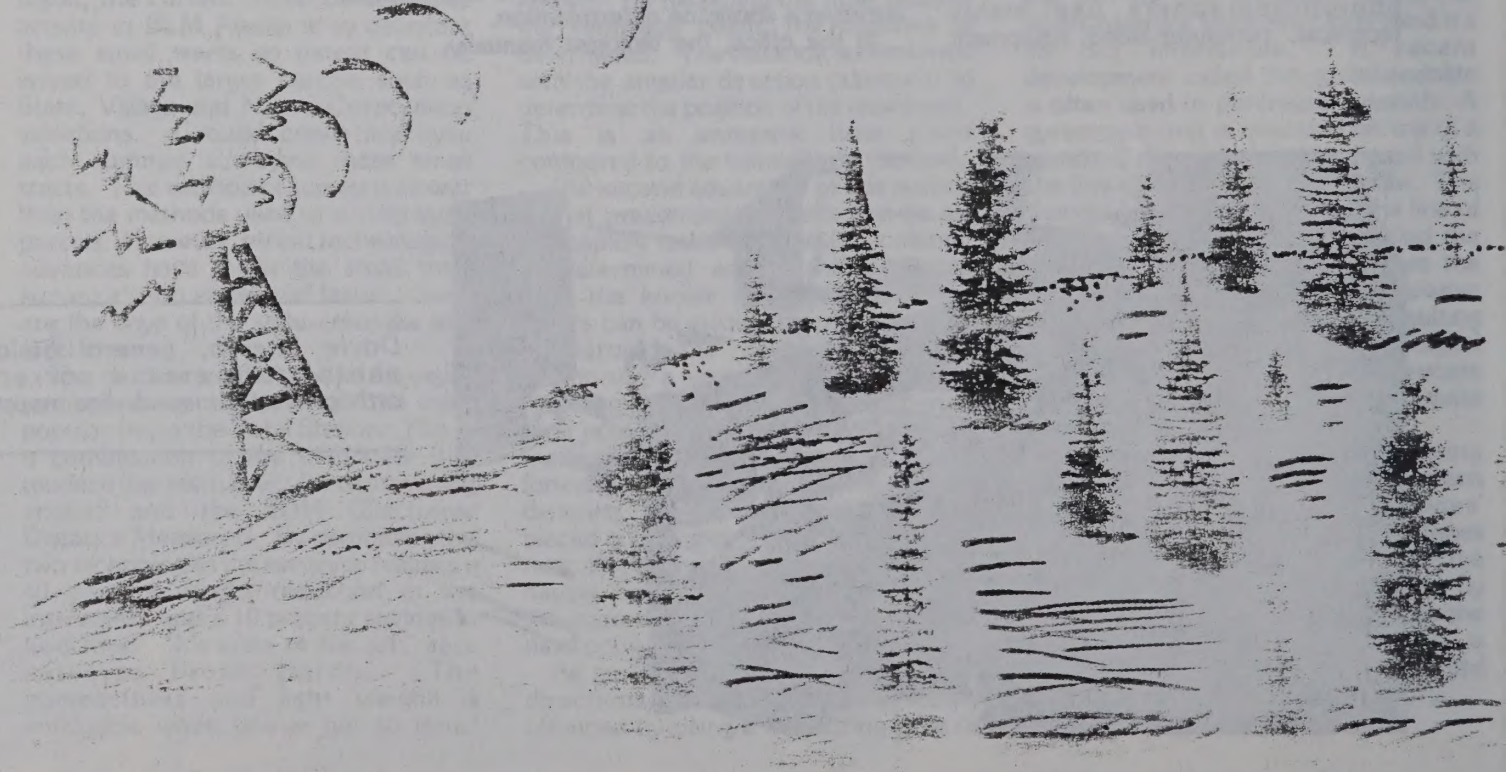
Most people think of meteors when they see occasional "shooting stars." In reality the earth is being constantly bombarded with up to eight billion meteors a day.

Most people think of meteors when they see occasional "shooting stars." In reality the earth is being constantly bombarded with up to eight billion meteors a day. Most of these are quite small; meteors as small as 1/32 inch in diameter can be used in meteor burst communication.

As a meteor is vaporized upon entering the earth's atmosphere, a trail of ionized gasses forms behind it. This trail is then used as a "space antenna." The meteor zone where this occurs is approximately 50 to 70 miles above the earth.

The Anchorage base station sends a nondirectional signal (probe) to the atmosphere where it is reflected back to earth in a "footprint" (i.e., an area approximately five miles by 25 miles over distances up to 1200 miles away). If a remote station is in the area, it can be activated by a recognizeable access code to respond with data that have been held in storage awaiting transmission. One base station can manage approximately 500 remote stations.

Since the connection between base and remote stations lasts less than one second, the data must be condensed into 16 character segments called "bursts" to permit transmission in the available time. The major application of meteor burst technology in BLM's Alaska program is in the Cadastral Survey Division.



Technology is Sky High in Alaska

The most sophisticated [illegible] technology in BLM's [illegible] program is in the Cadastral Survey Division.

With the passage of the Alaska Native Claims Settlement Act (ANCSA) in 1971 and the Alaska National Interest Lands Conservation Act in 1980, Alaska is in effect being subdivided in a massive land conveyance program. At the time of statehood in 1959, 99 percent of Alaska's 367 million acres was in federal ownership. After all claims are settled, 59 percent (217 million acres) will be federal land. Approximately 28 percent (104 million acres) will be state land, and 12 percent (45 million acres) will belong to Natives and Native corporations

Field surveys, marking precise boundaries on the ground and on detailed maps, are a key element in the land conveyance process; a valid survey must be completed before the land transfer is considered complete (i.e., patented). Legislation requires that the federal governmant pay for the necessary surveys. The acreage involved is overwhelming!

To accomplish this mission, BLM has established a survey program with both in-house and contract survey crews. BLM's cadastral survey program is a $10 million a year operation.

Survey base camps are established [illegible] throughout the entire [illegible] State. This past summer was typical; crews were stationed near the Arctic coast, the Bering Sea, near the Canadian border, throughout the interior, and in the panhandle region. Camps are supplied by air from Anchorage, Fairbanks, or other smaller cities depending on location. These camps can change location several times a year and must be able to operate in remote, isolated areas that have no existing communications systems nearby.

The meteor burst system is ideal for these conditions; it is small, portable, independent of other users, simple to operate, and can transmit a variety of messages on an as-needed basis. It is a key component of the survey camp operations. All that is needed in the field is a portable antenna, a keyboard the size of a small typewriter, and the receiver/transmitter.

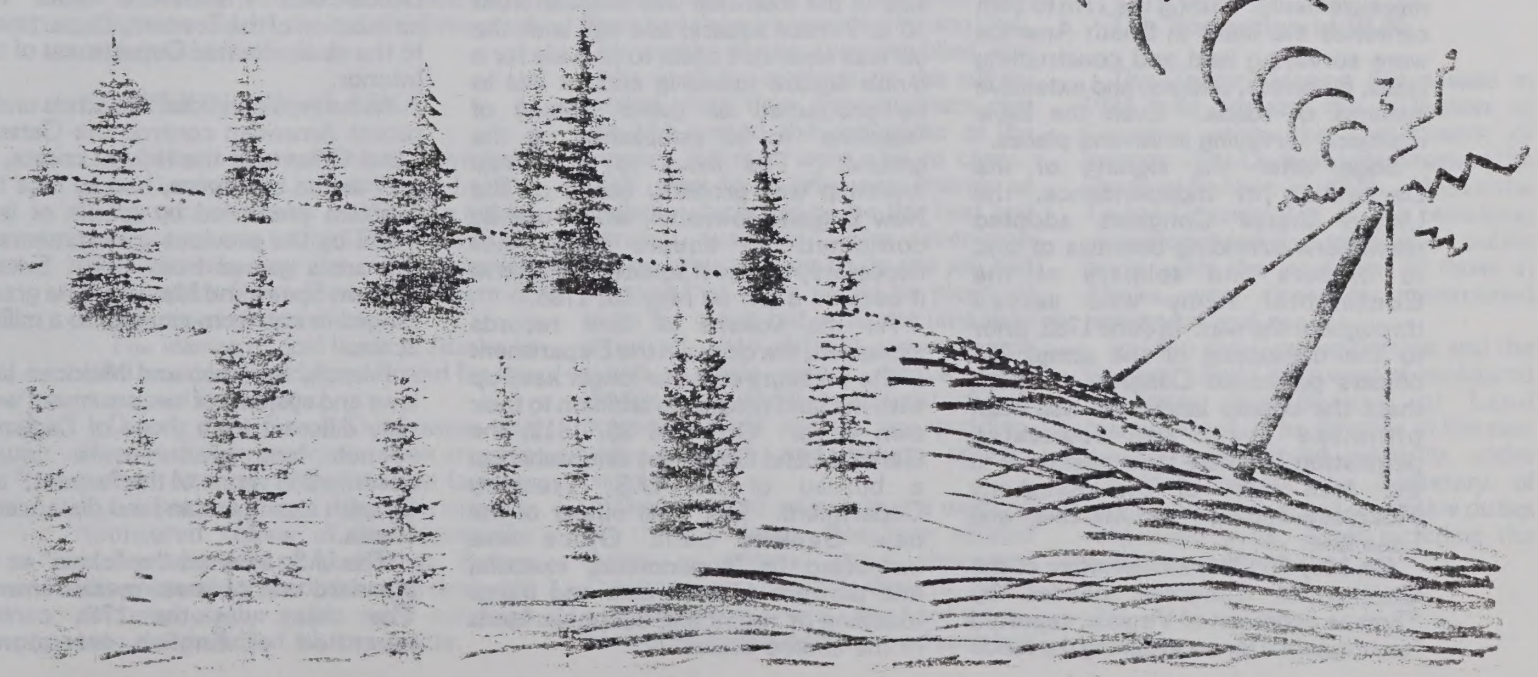
BLM and the other federal agencies in the meteor burst program in Alaska have played a major role in accelerating the development of current technology.

BLM and the other federal agencies in the meteor burst program in Alaska have played a major role in accelerating the development of current technology. New applications for this system will undoubtedly be found as the system is further refined and publicized. As with other high technology efforts, costs are decreasing and quality is improving. For example, costs for remote units have dropped from $5,700 to $3,000 in just six years; and the newer models are smaller in size and can actually select meteors so as to improve signal reception at the remote stations. Costs will continue to decrease as technology makes further advances and more competition enters the field.

Data needs for resource management will increase in complexity, but resource management budgets probably will not maintain the level of funding necessary to do the job, forcing resource management professionals to find the most cost-effective method of getting the data needed. Meteor burst technology will be a major consideration.

Private enterprise is beginning to enter the field. There is at lease one company in Alaska that can install and service a system for a user on a temporary or lease basis; data from remote stations can be relayed to an office computer anywhere in Anchorage.

There is no doubt that meteor burst technology will continue to fill an important communications niche in Alaska and elsewhere. It provides services that other communication systems, such as satellites, telephones, and microwaves, cannot perform as effectively.



Cadastral Survey - A Pa

Alaskans are not the only people to have a need for cadastral survey. Boundary disputes, along with religion, politics, and taxes, have awakened people's hidden passions throughout recorded history. For example, the Pharaohs of Egypt devised very precise methods of measurement which they used not only to build the pyramids but also to construct survey lines for taxing people. Four-thousand-year-old boundary stones indicate that the Babylonians, too, used survey measurements. During the 11th to 14th centuries the Incas in South America were surveying land and constructing cities, pyramids, bridges, and extensive systems of roads. Even the Bible mentions surveying in several places.

Soon after the signing of the Declaration of Independence, the United States Congress adopted resolutions providing bounties of land to officers and soldiers of the Continental Army who served throughout the war. In June 1783, prior to the disbanding of the army, 283 officers petitioned Congress to grant them the bounty lands that had been promised them and requested permission to make their selections in the area west of the Allegheny Mountains between the Ohio River and Lake Erie.

On May 7, 1784, a committee of the Continental Congress, headed by Thomas Jefferson of Virginia, reported "an ordinance for ascertaining the mode of locating and disposing of lands in the western territory and for other purposes therein mentioned." Jefferson is believed to be the original author. Part of the report which related to surveys made provision for the division of the public lands into "hundreds" of 10 geographical miles square and those broken into lots of one mile square each to be numbered from 1 to 100 and all lines to be laid out on the ground in the cardinal directions. Before the ordinance was passed, the size of the township was reduced from 10 to 7 miles square; and still later the bill was amended again to provide for a 6-mile square township and for lots to be protracted on paper instead of "sections" to be established on the ground. The move to a six-mile township was probably based on the New England township, which usually contained 36 square miles not necessarily a perfect square In this form it became a law on May 20, 1785.

As the volume of land records increased, the clerks in the Department of the Treasury could no longer keep up with the land records in addition to their own work. On April 25, 1812, the General Land Office was established as a bureau of the U.S. Treasury Department. The chief officer of the new General Land Office was instructed to "superintend, execute, and perform all such acts and things touching or respecting the public lands of the United States."

During the early 1800s Congress began encouraging settlement on public lands. A westward migration of optimistic, land-hungry people grew daily. The laws governing the sale of public lands called for survey prior to settlement, but with the rush westward the survey lines sometimes ran through fields already plowed.

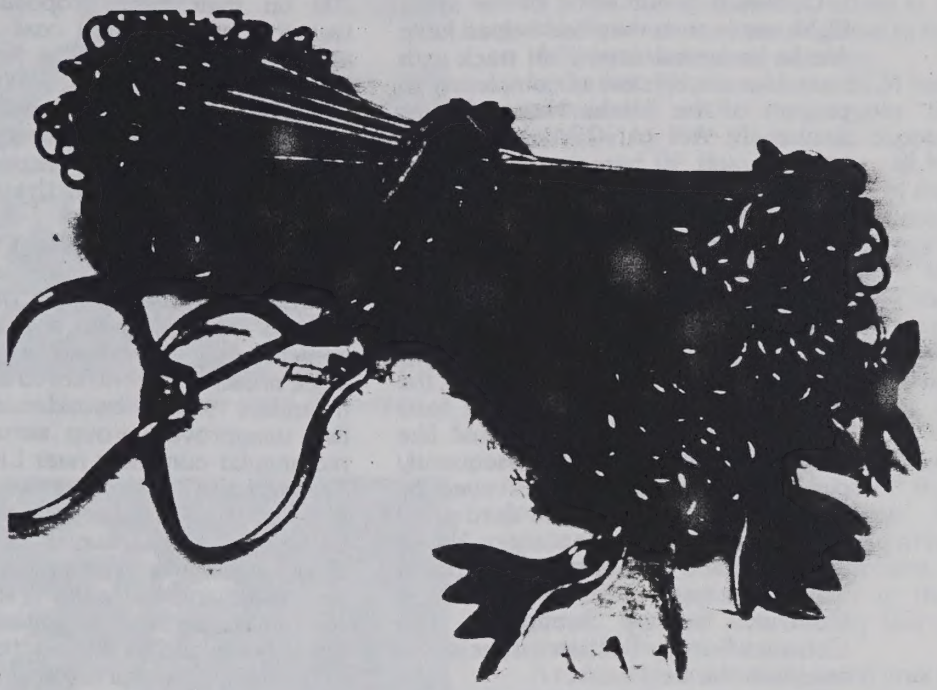
In 1849, in the face of the gold rushers in California, Nevada, Oregon, Idaho, Montana, South Dakota Black Hills, and later in Alaska, the General Land Office was transferred from the jurisdiction of the Treasury Department to the newly created Department of the Interior.

As surveys extended into lands under recent American control, the General Land Office and the federal courts, as well as the surveyors, had to face the problem presented by grants of land made by the previous governments of the areas gained from Great Britain, France, Spain, and Mexico. The grants ranged in size from city lots to a million acres.

French, Spanish, and Mexican land laws and systems of measurement were very different from those of England. French land grants were usually described in terms of the "arpent," and Spanish and Mexican land distances in "varas."

The U.S. adopted the "chain" as the standard unit of linear measurement. The chain was the 17th century invention of English astronomer

# of Our Nation's History



(left) George Washington, America's first surveyor

(middle) The solar compass, the early surveyor's tool of the trade

(right) The U.S. adopted the chain as it's unit of linear measurement. The chain is 66 feet long. In its early construction it was made of iron; later, heavy steel wire was used. One acre is equal to 10 square chains.

Edmund Gunter. Gunter's chain was 66 feet long and was divided into 100 links. The chain remained as the standard measurement until it was replaced by the steel ribbon tape around 1900.

During the second half of the 19th century Congress passed several acts that authorized grants of public land for various purposes, including the Homestead Act (1862), the Act of July 1, 1862 (which granted public lands for railroad rights-of-way), and the Morrill Act (which authorized public land grants to aid in the establishment of certain state colleges).

SURVEYING IN ALASKA

Alaska was the last acquisition to add public land to the United States. In 1904 the first contract for an Alaskan public land survey was let for 12 mission sites. The following year the initial point for the Copper River Meridian system of surveys was established.

The leasing of coal lands in Alaska in 1914 created a sudden demand for the survey of coal fields.

During the Great Depression the Roosevelt Administration took steps to asasist stricken Midwest farm families by establishing a government-sponsored colony in the Matanuska Valley northeast of Anchorage. Before the colonists arrived, the most desirable sections of the valley were surveyed into two hundred 40-acre tracts.

First Surveys of the Denali Park Boundaries

When President Woodrow Wilson set aside two million acres for a national park in 1917, the boundaries of the new park needed to be surveyed.

Surveying Alaska was rough. Men who wanted to survey in Alaska were expected to care for themselves and to be prepared for emergencies. There were no budget provisions for a cook, medic, or even roustabout. All the supplies and gear the men took with them had to be transported by dog sled. The weight of the concrete-filled iron posts used for markers on the survey totaled more than three-quarters of a ton and limited the remainder of the supplies the men were able to carry. Each man took only one change of clothes, which had to be the best and warmest available. The seven-man survey crew chosen to do the job had planned that there would be plenty of game for meat; but in all the time they were out, they did not see even one rabbit. Their dinner menus were, therefore, limited to beans, dehydrated potatoes, dried apples, rice pudding, coffee, cocoa, and baking powder biscuits.

They worked seven days a week to get the job done. The men rotated duties as scouts, solar observers, chainmen, and posthole diggers. Being a posthole digger was very hard work. Each post weighed 16 lbs., and each had to be buried 28 inches into the frozen ground.

The men had to snowshoe across open spaces, set a post every mile, slash a 10-foot wide passage through tall trees when the line crossed timbered country, and pile rock cairns nearly six feet high on the high points of barren areas. To celebrate the distance covered, they put up a sign — "National Park Boundary." One of the men added another line — "If you've come this far, brother, you may as well go on in."

The Formation of BLM

The Taylor Grazing Act passed in 1934 and formed the Division of Grazing within the Department of Interior. The Division was renamed the Grazing Service in 1939. Under the Taylor Grazing Act all the remaining unappropriated and unreserved public lands, with the exception of those in Alaska, were closed to unrestrained settlement and use.

In 1946 the Grazing Service and the General Land Office were consolidated to form the Bureau of Land Management. The director of the new bureau was granted authority, under the direction of the Secretary of Interior, to perform all executive duties respecting public lands including the public land surveys.

Contract Surveys - The Business End

Contracting out some of the areas BLM needs to survey has helped keep Alaska cadastral survey on track with their overall objective of completing 90 percent of the Alaska Native Claims Settlement Act (ANCSA) boundaries by 1986 and 90 percent of the state selection boundaries by 1996. ASO's Contract Survey Section was formed in 1974 to supplement cadastral's in-house survey capabilities in meeting this objective. Since 1974 almost 20 million acres have been surveyed through contracts to private surveyors. With so many millions of acres left to survey, the state of Alaska and the Natives have prioritized the areas they would like surveyed first, and BLM subsequently picks these areas to be surveyed by contract. BLM also has a third-party agreement whereby the state of Alaska advertises and awards survey contracts which have been prepared by the BLM Contract Survey Section. The Contract Survey Section inspects and monitors the field work.

During the last five fiscal years, the contract section has primarily concentrated its survey efforts in Southeast Alaska. This was done because past survey experience proved that private engineering and surveying firms could survey the rough, heavily timbered areas of Southeast Alaska much more economically and efficeintly than could the in-house cadre of land surveyors. This was due to the use of professional loggers to cut and clear the survey boundary lines. The professional loggers double the production rate of the BLM in-house surveyors because of their acquired expertise in clearing the survey line of trees and brushes.

The Contract Survey Section develops and prepares survey plans and technical specifications and from these provides representative cost estimates for the project areas where the survey work will take place following award. Once the technical and cost proposals are submitted, the contract section conducts technical evaluations and rates the best qualified firms. Each firm submitting a proposal must be licensed to practice land surveying in Alaska and (1) their bid must specify in step-by-step detail how the entire survey project will be done and (2) they must present a cost proposal. The contract section breaks each bid into two parts and scores the two parts separately. A firm may score 900 out of 1000 points on their technical proposal explaining how they will survey the project and score 700 on their cost proposal. The technical proposal and cost proposal are weighed equally. The firm which has the best combined score (technical and cost) is recommended to the contracting officer for contract award. A BLM field inspector inspects each contract to ensure that BLM's specifications are met.

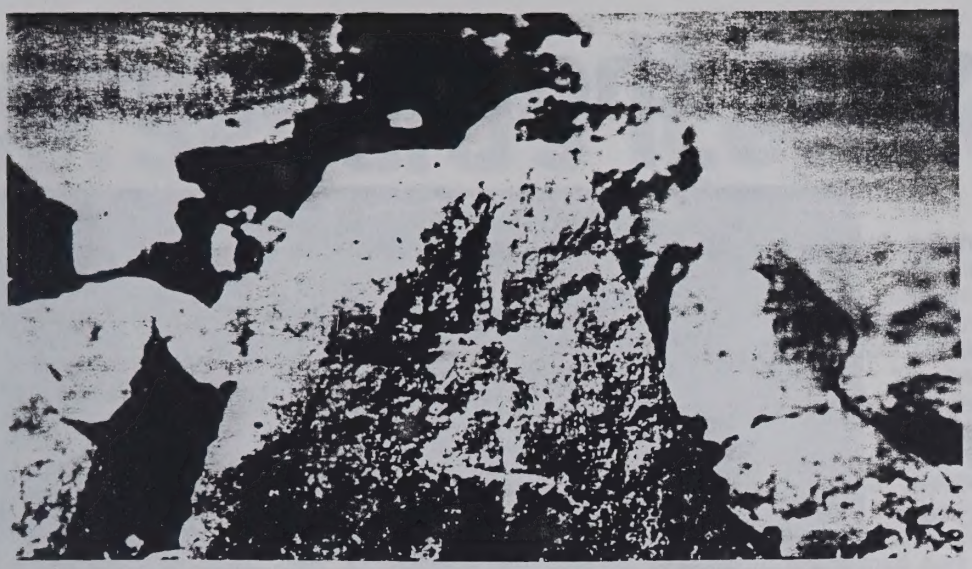
This summer's contract surveys include three large Native allotment contracts: two near Bethel, one on the Seward Peninsula, and one small NA contract near Haines within the state eagle preserve; a contract to determine meanders (water boundaries) within five unapproved group surveys, five rectangular contracts near Livengood, Tazlina/Lake Louise, three of which are in Southeast Alaska at Pelican, Thoms Lake/Place, and Douglas Island; also three continuing 1984 projects in the southeast; and lastly the first stage of the total required cadastral surveys on Unalaska Island in conjunction with a U.S. Geological Survey topographical mapping project.

Working in the contract section requires expertise in all phases of cadastral surveying. This includes critical review, drafting, writing special instructions, principles of re-survey, and retracement as well as original survey, mineral surveys, small tracts, Native allotments, etc. There is no phase of cadastral surveying, as outlined in the 1973 Manual of Surveying Instructions, that the contract section personnel does not, at one time or another, deal with directly. Contract survey personnel must possess a prolific knowledge of the regulations set forth in the Code of Federal Regulations and a comprehensive knowledge of the procurement process. Finally the contract inspector has considerable responsibility and many times must function as a quasi-land examiner.

One of the earliest survey markers - a square wooden cedar post on which survey information was scribed.

photos courtesy of Dowl Engineering Co

Bearing trees are marked to help locate a nearby monument. This is one i marked Township 77, Range 83 E Section 6, meander corner bearing tre



In the early years of American surveying, rocks were often used as survey markers. This one is a quarter corner marker.

A survey monument set in a mound of stones

A brass cap on an iron post.

Survey Monuments in Alaska

Surveyors are always experimenting with new and better survey techniques and equipment. Monuments have changed considerably since the Ordinance of May 20, 1785, which established surveying in the United States. In the early years notched stones or wooden posts inscribed with the township and range usually marked a survey corner. Sometimes this meant that the surveyor had to carry wooden posts or even stones with him. By 1908 surveyors marked corners with an iron pipe with a brass cap attached on top.

In Alaska, arctic conditions make surveying unique. Permafrost is common; what works fine in the Lower 48 doesn't always work here. For instance when iron posts are set in permafrost, the post absorbs the sun's heat. As the post becomes warm, the permafrost around the post begins to melt. Soon the marker is sitting in a mud hole which sometimes grows to be a 15-20 foot wide pond of water.

In the last 10 years Alaska BLM has experimented with many types of markers. In 1976 BLM tried copper coated rod. A year later BLM converted to aluminum because of the lighter weight. Rods holding the survey markers are usually driven at least eight feet into the ground in an effort to prevent permafrost from pushing the marker back out of the ground. This is done by connecting the three foot sections together by a threaded plug and driving the sections with a pneumatic hammer.

The surveyors have also found that it is important that the snow be off the ground before surveying is begun. A few years ago a rod was driven into what the surveyors thought was ground. When they came back later in the summer, the rod was waving like a flagpole 25 feet in the air.

A rod is driven into the ground until it reaches the "point of refusal" or a point where it won't go down any farther. In one area a series of rods were driven 260 feet into the ground before reaching the point of refusal.

A few years ago brightly colored cones were placed over survey monuments to make them easier to find. This worked fine until a fire burned the area. The cones acted as mini-ovens melting, the aluminum survey caps underneath the cones. Triangular aluminum triangular markers with flourecent tape on the top are now used, replacing the cones. This requires driving another series of rods about 10 feet from the corner monument and then bolting the triangular markers on top of the rod.

Some agencies are experimenting with stainless steel survey rods and caps. In recent years BLM has been adding a magnet to each survey cap so it can be found with a metal detector.

Survey monuments will continue to change as new ideas are tried, but we've come a long way from the time of using notches in stones.

Surveying the last frontier

Surveying the Contents o

Every year as the snow begins to melt, the ice breaks on the rivers, and the mosquitoes appear, BLM field survey crews scatter to all parts of Alaska for another survey season.

Last year the Branch of Field Surveys sent 24 survey crews to the field in locations from Ketchikan in southeast Alaska to Point Hope in the far northwest corner of the state, from Nome on the Bering Sea to Slana near the Canadian border, and to many sites in between.

How, you might ask, did BLM get involved in such an undertaking?

At the time of statehood in 1959, approximately 99 percent of Alaska's 367 million acres was in federal ownership. After all the claims are settled, 59 percent (217 million acres) will be federal land.

While it is true that the federal government has always been involved in surveying activities in Alaska, recent events have dramatically increased the BLM's workload in the 49th state. As a result of the passage of the Statehood Act of 1959, the Alaska Native Claims Settlement Act (ANCSA) in 1971, and the Alaska National Interest Lands Conservation Act in 1980, Alaska is, in effect, being subdivided in a massive land conveyance program. At the time of statehood in 1959, approximately 99 percent of Alaska's 367 million acres was in federal ownership. After all claims are settled, 59 percent (217 million acres) will be federal land. Approximately 28 percent (104 million acres) will be state land, and 12 percent (45 million acres) will belong to Natives and Native corporations.

A valid survey must be completed before the land transfer is considered complete (i.e. patented), and legislation requires that the federal government pay for the work. The acreage involved is overwhelming

To accomplish this mission, BLM has established a program with both in-house and contract survey crews. This program is now a $10 million a year operation. Although this sounds like a lot of money, some estimates indicate that it could take up to 50 years to complete the projected workload with this continued level of funding.

What is BLM's secret weapon? Organization, teamwork, and technology!

A survey camp at Icy Bay near Yakutat

Soon after the Christmas holidays, the surveyors begin preparing for the summer field season. Don Beck, Chief of the Branch of Field Surveys, explained the process:

"After priorities have been set and decisions have been made as to where crews are going, the preparation process begins in earnest. First, crew sizes are determined by workload and a tentative location for a base camp is chosen. Then the location, whether it is a village, remote lake, abandoned airstrip, or large city, is visited to see what facilities, if any, are available. These facilities may vary from a hotel or motel to a gravel pad for a campsite along an unused airstrip miles from the nearest village. Once the location and existing facilities are determined, a decision is made as to what additional supplies and/or camp equipment will be needed for the project."

For a two week period in May, there is a non-stop flurry of activity in the Anchorage district warehouse., A glance at the field schedule shows why--the majority of the field crews start work at the same time. These crews need supplies, lots of supplies. Literally everything, including the proverbial kitchen sink, not to mention first aid kits, backpacks, tents, tools, stoves, generators, cook kits, and tons of food, is needed.

A large survey camp of 14 to 16 people will typically need more than 200 items weighing up to 65,000 lbs. and will use more than 60,000 gallons of fuel during the summer.

A large survey camp of 14 to 16 people will typically need more than 200 items weighing up to 65,000 lbs. and will use more than 60,000 gallons of fuel during the summer.

All these items must be transported to and from some of the most remote country in the United States, kept track of, maintained, and repaired. Much of this effort is accomplished by the Branch of Field Support in the Anchorage district warehouse. The warehouse has approximately 2,000 items on stores account, an inventory now approaching $1 million. The 15 permanent employees serve in administration, warehouse, and electronics maintenance functions.

Field survey supply is a year-round operation. During the winter, tools machinery and equipment are cleaned repaired or replaced as necessary. However, it's the summer when things are the most hectic.

Just keeping track of the items and their locations is a major facet of the operation. Up until 1982, this was done by hand with a card-sort system which

Mr. Seward's Icebox

one employee described as "a monster," But in May 1983, a Honeywell computer came to the rescue and efficiency rapidly improved.

Cadastral survey contracts for aircraft use totalled $1.8 million in 1983. These flights delivered more than 880,000 lbs. of equipment to field camps throughout the state.

Getting the supplies to the field and back is the other half of the operation. In 1983, 79 cargo flights left from the Campbell Airstrip located immediately adjacent to the warehouse. Additional flights departed from the Alaska Fire Service in Fairbanks, Elmendorf Air Force Base, and other airfields used by private contractors. Cadastral survey contracts for aircraft use totalled $1.8 million in 1983. These flights delivered more than 880,000 lbs. of equipment to field camps throughout the state. An additional $338,000 was spent on rental aircraft to deliver another 490,000 lbs. of equipment. The BLM saves money wherever possible by combining cargos for several related destinations and sharing aircraft use with other agencies doing field work, such as the Bureau of Indian Affairs, National Park Service, and Fish and Wildlife Service.

Another essential resource for a successful field season is people. In additional to the full-time BLM employees, there are 50 to 60 seasonal employees hired by the Cadastral Survey Division for work from late May to late September. These seasonal employees come at their own expense from all parts of the United States and obviously enjoy their work; approximately 70 percent of last year's crews are expected to return this season. Many employees have three or four season's experience.

Approximately one-half of the seasonal employees consist of college students majoring in surveying or engineering. BLM has cooperative education programs established with more than a dozen colleges and universities. Upon graduation, the coop students are potential full-time BLM employees if vacancies exist. Last summer a college professor worked on a survey crew with his students to get first-hand knowledge of what BLM does and what job skills are most essential. He will use this information to assist in the development of the curriculum at this university so that the students will be better qualified to work in "the real world".

During their first week of summer employment the cooperative education students and temporary employees participate in three to four days of rigorous training on subjects ranging from helicopter safety to bear psychology, first aid, machete safety, and surveying procedures. Chief Beck said, "Cadastral survey has a very good safety record despite the constant exposure of a large number of people to a variety of hazardous situations. For example, last summer we had only 15 personal injuries. I'm sure that our training program plays a significant role in keeping the accident rate down."

Additional field work is done by survey crews hired by private contracts under contract to BLM. Francis Eickbush, deputy state director for cadastral surveys, explained, "We like to use the surveying expertise of private contractors when our budget allows because we can accomplish additional work without increasing our own staff and equipment needs."

As you can see, surveying over 300 million acres is no easy task, but the Alaska BLM is tackling the job with an effort equal to the challenges posed by the largest state in the Union.

A brass cap survey monument

Life on a 1847 Wisconsin Survey

Deputy surveyor Harry A. Wiltse describes life on an 1847 Wisconsin survey.

"The survey lines ran through many miles of insect-infested swamp. In order to do our work, we had to carry all our food and equipment on our backs as we waded through high water and climbed over fallen trees. For four long weeks we endured attacks by clouds and mosquitos. Our clothing was wet both day and night. We finally ran out of food and had to make a forced march in search of provisions. Wearing clothes that were nearly rotted away, we struggled for three days to reach a place where we could find food. During those three days there was nothing at all to eat."

Little wonder Wiltse closed his written account of this survey by stating that he "would not again, after a lifetime of experience in the field and a great fondness for camp life, enter upon the same or a similar survey at any price whatever."

Alaska Cadastral Co-op Ed. Program - Largest in the BLM

Alaska BLM's Cadastral Survey Program has the largest Cooperative Education Program in the Bureau of Land Management. With approximately 30 co-op students on their payroll, Cadastral's co-op program provides college students with on-the-job experience while working toward their degree. By signing on as a cooperative education student, the student agrees to work for BLM a set number of months per year prior to graduating from college. After they graduate, BLM can convert them to permanent status without further competition if there is an opening available. They may also be picked up by one of the other state offices if Alaska doesn't have vacancies. The program is very beneficial to both the student who gains work experience and to BLM. "So far we've been able to place almost everyone" says Cadastral's training specialist Ann Hagan. By developing the co-op student with on-the -job training and formal education, BLM is able to get the ideal employee that it needs.

Cadastral's program is geared toward surveying or engineering students in their sophmore year. This allows for two work periods with BLM before graduation which is necessary to be eligible for a conversion.. Alaska BLM has a co-op agreement with the following colleges: Michigan Tech. University, Ferris State College (Michigan), California State University - Fresno, Oregon Institute of Technology, University of Maine at Orono, Florida A&M University, Virginia Poly Tech., University of Wisconsin-Madison, and the University of Southern Colorado. Each year managers from Cadastral Survey go to the schools to recruit new students. "We present a slide show and a video presentation, offer general information and interview interested applicants. We generally look for someone who has experience which would help them work with a crew in a remote setting. We also look at their transcripts, their general experience and their interest in a future with BLM" says Jerry Pinkerton of Cadastral's Field Surveys. The schools often set up a special BLM day and invite BLM representatives from the Lower 48 as well as Alaska. Students who are selected for the program are requested to work either one fall or spring semester to gain a full summer of field camp experience. Occasionally as the snow arrives in Alaska they are detailed to BLM offices in the Lower 48 to gain additional experience in different types of terrain and other types of BLM surveys.

Several of the Cadastral surveyors now working for BLM are graduates of the Co-op Ed.Program. Lester Fischer and John Toms are two of the first Cadastral co-op ed.students. Both were attending Oregon Institute of Technology (OIT) in Klamath Falls Oregon, when the first agreement was set up between the head of the surveying department at OIT and Irving Zirpel who was then in BLM's Oregon State Office.

According to Fischer, of the five who signed the first co-op agreement, four ended up working for BLM. "I wouldn't have financially been able to make it through school without the co-op program. I was able to get my education and a job. I went to work the day after I graduated. Employers like to hire someone with experience. It's a great way to gain experience and get your education too" says Fischer. "I found the things I learned during the school year I could put to practial use on the job. What I learned on the job I could take back to the classrom." says Toms. "I later had co-op students working for me" says Fischer.

In some cases BLM hires the college survey instructors to work in the summer field camps to help them get a better feel for what their students are learning.

"The co-op program has been very successful for BLM. Not only are we able to obtain experienced, highly qualified employees for help during the field season but we have an excellent source for permanent employees. These employees with two or three seasons of BLM experience, plus a degree in surveying or engineering, make the best possible new employees" says Pinkerton.

Bureau of Land Management

Alaska State Office
701 C Street, Box 13
Anchorage, Alaska 99513

Return if not delivered in 10 days
OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
DEPARTMENT OF THE INTERIOR
INT 415

U.S.MAIL

ALASKA PEOPLE